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An Experimental Study of the Equilibrium Diagrams of Two Binary Systems: Acetic Acid-Water and Glycolic Acid-Water

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AN EXPERIMENTAL STUDY OF THE EQUILIBRIUM DIAGRAMS OF TWO BINARY SYSTEMS: ACETIC ACID-WATER AND GLYCOLIC ACID-WATER

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by

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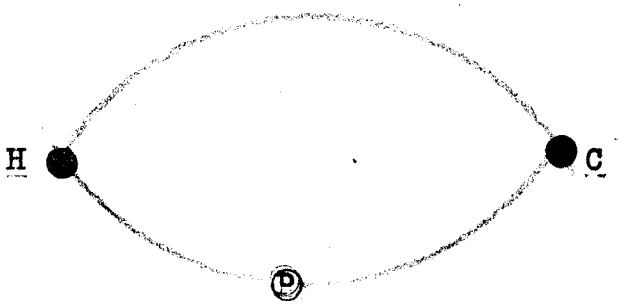
VITA

The writer was born in Manteno, Illinois in 1918. She was educated in Chicago, receiving her high school diploma from Immaculata High School in 1935 and the Bachelor of Arts degree from Mundelein College in 1939. Since June 1939, she has been a graduate assistant in the Department of Chemistry at Loyola University.

INTRODUCTION

The purpose of this work is to investigate, by means of cooling curves, the equilibrium diagrams of the systems Acetic Acid-Water and Glycolic Acid-Water. No data on these systems could be found in the literature after a comprehensive search of the Chemical Abstracts. It was hoped, by a series of such investigations, to throw some light on the addition of water to the carbonyl bond.

DESCRIPTION OF APPARATUS



bare constantan wire # 28

insulated copper wire # 30

P- A Brown electric pyrometer with an arbitrary scale ranging from 0 to 100. The indicator hand of the pyrometer is set at 0 by means of a set screw on top of the instrument when both junctions of the thermocouple are at room temperature. The pyrometer must then be calibrated and is tapped occasionally while in use to prevent the indicator from sticking.

H- Constant temperature hot junction of the thermocouple. A 1 liter round bottom flask is fitted with a two hole cork covered with tin foil accommodating a thermometer and a condenser set for refluxing. The flask contains distilled water, used in both systems and is heated by a Bunsen burner. The copper and

constantan wires of the junction are joined with silver solder, and the end placed through the hole in the cork with the thermometer and at the level of the thermometer bulb.

C- Cold junction of the thermocouple. The wires are joined with silver solder, and the end inserted through a glass tube fitted with a notched cork. A spiral shaped Nichrome wire fitting through the notch in the cork was used as the stirrer. This was then inserted into the test tube of the sample to be cooled. This test tube was put into a larger tube lined with paper for insulation. This is now immersed into a beaker of acetone and dry ice. The beaker is one of a nest of three separated from one another by layers of cotton for insulation. The sample was well stirred upon cooling.

PROCEDURE

The procedure was performed in the following manner:

1. The water used in the work was purified by careful distillation, while the acetic acid was purified by a series of fractional distillations. The Glycolic Acid was the purest obtainable from Eastman Kodak Company. It was dried in a desiccator before use. It gave a melting point of 78.5°C. as compared to 79.0°C. given in Lange's Handbook.

2. The pyrometer apparatus was set up. Boiling distilled water furnished the constant temperature of the hot junction of the thermocouple. A dry ice-acetone bath was prepared to freeze the mixtures.

3. The pyrometer was calibrated using pure liquids of known freezing points. Cooling curves of Carbon Tetrachloride, Water, Benzene, Acetic Acid, Aniline, and Glycolic Acid were used. Samples of these were placed in a small test tube which contained a stirrer and the cold junction of the thermocouple. The tubes were inserted in the freezing bath and stirred continuously, while readings were taken from the pyrometer every fifteen seconds. A calibration curve

was determined by plotting the freezing points of the liquids in terms of the arbitrary pyrometer scale against the freezing point in degrees Centigrade.

4. Eighteen samples of the Acetic Acid-Water system were carefully weighed out in the range from 0% to 100%. Each sample consisted of approximately 15 grams, weighed to an accuracy of 0.2 milligrams.

5. These samples were cooled in the same manner as described in step 3. The cooling curves were plotted, and the freezing point of each mixture was determined and converted into degrees Centigrade by means of the calibration curve. A few of the samples were frozen completely solid to serve as a check on the true eutectic point. The percentage composition of each sample was computed exactly. By plotting percentage composition against temperature of phase changes in degrees Centigrade the equilibrium diagram for the system was obtained.

6. In preparing the Glycolic Acid-Water samples, approximately 15 grams of water was weighed out each time and the amount of glycolic acid varied. The technique employed was the same as in the Acetic Acid-Water system.

THE

ACETIC ACID - WATER

SYSTEM

PERCENTAGE COMPOSITION OF THE ACETIC ACID

WATER SAMPLES

Test Tube Number	Weightof Acetic Acid in grams	Weight of Water in grams	% of Water
1		0.0000	0.00
2	14.0375	1.2798	8.35
3	12.6396	1.9594	13.42
4	11.9239	3.2500	21.41
5	9.4125	3.9050	29.32
6	9.6959	5.1177	34.54
7	9.1163	5.9524	39.50
8	8.3382	5.8715	41.32
9	7.7480	7.1644	48.04
10	6.7851	7.8103	53.51
11	5.5708	9.0498	61.89
12	4.4864	9.7463	68.48
13	3.7182	10.9715	74.68
14	2.8787	11.7440	80.31
15	1.9705	12.9712	86.81
16	1.4947	13.7658	90.20
17	1.0798	13 7936	92.74
18	0.0000		100.00

CALIBRATION OF THE PYROMETER FOR THE ACETIC ACID-WATER SYSTEM

The indicator hand of the pyrometer was set at 0 by means of a set screw on top of the instrument when both junctions of the thermocouple were at room temperature. The hot junction was then placed in water boiling at 98.8 degrees Centigrade while the cold junction was inserted in the tube containing the sample and immersed in the freezing bath. Pure liquids with known freezing points were used to calibrate the instrument. The pyrometer readings taken at the freezing point of the liquid, and the freezing point in degrees Centigrade are listed below:

Liquid	Pyrometer Reading at Freezing Point	Freezing Point in degrees C.
Acetic Acid	62.2	16.5
Benzene	69.8	5.5
Water	72.5	0.0
Carbon Tetrachloride	86.9	-23.0

DATA ON COOLING CURVES FOR THE ACETIC ACID - WATER SYSTEM

Test Tube Number	#1	#2	#3	#4	#5
Per Cent Water	0.00	8.35	13.42	21.41	29.32
Pyrometer Readings taken at 15 second intervals	55.5	55.5	55.8	56.5	55.9
	58.5	60.2	58.5	62.0	56.9
	61.5	64.5	62.0	63.5	61.0
	62.3	69.0	65.0	66.5	64.0
	62.2	70.0	68.1	69.0	66.5
	62.2	70.1	70.5	71.7	69.0
	62.2	70.3	72.7	73.5	71.0
		70.5	73.7	76.0	73.0
		71.0	73.5	77.5	75.5
		71.6	73.8	79.3	77.3
		72.2	74.5	79.5	78.5
		72.5	75.5	79.3	80.0
		72.8		79.5	81.5
		73.5		79.9	82.5
		74.5		80.3	83.9
		74.7		80.5	84.8
		75.5		80.7	85.9
				81.0	84.5
					84.2
					84.3
					84.5
					84.7
					85.0
					85.3
					85.7
					86.0
Pyrometer Readings at Freezing Point	62.2	70.0	73.6	79.5	84.5
Freezing Point in Degrees Centi.	16.5	5.2	-1.0	-10.0	-18.0

Test Tube Number	#6	#7	#8	#9	#10
Per Cent Water	34.54	39.56	41.32	48.04	53.51
Pyrometer Readings at 15 second intervals	61.3	61.0	60.5	61.3	62.5
	62.0	63.5	62.0	63.0	63.5
	64.5	67.2	64.5	66.0	65.5
	67.3	70.7	67.0	68.0	67.5
	70.0	73.7	70.0	70.0	69.1
	72.7	76.5	72.0	72.0	70.9
	75.3	79.0	74.8	73.5	72.5
	77.3	81.0	76.8	75.2	73.5
	79.5	83.5	78.7	76.9	75.5
	81.5	85.5	80.0	78.0	76.5
	83.3	87.2	82.5	79.2	77.7
	85.0	89.0	84.3	80.5	78.6
	86.5	90.5	85.5	81.7	79.9
	88.0	92.0	87.0	82.7	80.7
	89.3	93.5	88.0	83.8	81.6
	90.4	94.7	89.5	84.5	82.5
	91.5	94.5	90.5	85.3	83.5
	93.0	93.7	91.5	86.3	84.4
	94.0	93.5	93.2	87.0	85.1
	94.8	93.5	94.2	87.5	85.6
	95.0		95.0	88.4	86.5
	93.5		94.3	89.0	86.9
	91.7		94.3	89.5	87.5
	92.0		94.4	90.3	88.0
	92.1		94.6	90.9	88.5
	92.1		95.2	91.3	89.0
	92.1			91.9	89.7
				92.5	90.3
				91.1	90.9
				91.0	90.2
				91.3	91.5
				91.4	90.0
				91.5	90.0
				91.6	90.0
				91.8	90.1
				91.9	90.5
				92.0	90.7
					90.8
					90.9
Pyrometer Reading at Freezing Point	92.1	93.5	94.3	91.2	90.0
Freezing Point in Degrees C.	-29.8	-32.0	-34.5	-28.5	-26.5

Test Tube Number	#11	#12	#13	#14	#15
Per Cent Water	61.89	68.48	74.68	80.31	86.81
Pyrometer Readings at 15 second intervals	62.5 63.5 65.6 68.0 70.5 72.1 73.0 76.0 77.5 78.8 80.1 81.5 83.5 84.5 86.5 86.5 86.7 86.7 86.7 86.8 87.1 87.3 87.5 87.7	59.9 63.5 66.5 69.5 72.5 75.5 78.0 80.3 82.3 83.5 83.7 83.9 84.2 84.7 85.1 85.6 86.0 86.5 86.9 87.5 87.9	60.0 62.5 65.2 68.0 70.7 72.9 75.5 77.5 79.0 81.0 82.2 82.3 82.5 82.6 83.0 83.2 83.5 83.9 84.2 84.5	60.5 62.5 65.5 68.0 69.9 72.0 74.0 76.1 78.0 79.5 81.0 81.3 81.3 81.4 81.5 81.5 81.5 82.0 82.3 82.5 82.8 83.0 83.0 83.3 83.5	61.5 63.5 66.0 68.4 70.7 72.5 74.5 76.5 78.0 79.5 79.6 79.9 80.0 80.0 80.0 80.0 80.3 80.5 80.7 80.8 81.0
Pyrometer Readings at Freezing Point	86.6	83.7	82.3	81.3	80.0
Freezing Point in Degrees C.	-21.4	-17.0	-14.5	-13.0	-11.0

Test Tube Number	#16	#17	#18
Per Cent Water	90.20	92.74	100.0
Pyrometer readings at 15 second intervals	62.0 63.0 65.7 68.0 70.5 72.9 75.0 77.0 79.0 79.2 79.4 79.5 79.5 79.7 79.8 80.0 80.2 80.4 80.6 80.8 80.9 81.1	60.2 63.0 65.0 67.0 69.2 71.0 72.5 74.0 75.5 77.0 78.1 78.0 78.0 78.1 78.2 78.2 78.2 78.3 78.4 78.5 78.5 78.5 78.7 78.8 78.9	57.0 59.0 61.0 62.7 64.5 66.5 68.0 69.5 71.0 72.3 72.5 72.5 72.5
Pyrometer Reading at Freezing Point	79.5	78.0	72.5
Freezing Point in Degrees C.	-10.0	-8.0	0.0

Test Tube #7 cooled down to eutectic:

61.0	76.5	87.2	94.7	93.5
63.5	79.0	89.0	94.5	93.5
67.2	81.0	90.5	93.7	
70.7	83.5	92.0	93.5	
73.7	85.5	93.5	93.5	

Pyrometer reading at eutectic is 93.5

Test Tube #9 cooled down to eutectic:

60.1	80.1	90.7	92.2	92.8
61.7	81.5	91.5	92.5	92.8
64.5	83.0	90.9	92.7	92.8
66.9	84.5	91.0	92.9	92.8
70.0	85.7	91.1	93.1	92.8
72.3	86.9	91.1	93.4	92.8
74.5	87.9	91.5	93.5	92.8
76.5	88.9	91.7	93.4	
78.3	90.0	92.0	93.3	

Pyrometer reading at eutectic is 92.8

Test Tube #16 cooled down to eutectic:

62.0	79.2	80.6	83.4	92.2
63.0	79.4	80.8	84.2	93.5
65.7	79.5	80.9	85.1	93.7
68.0	79.5	81.1	86.0	93.5
70.5	79.7	81.5	87.1	93.5
72.9	79.8	81.7	88.0	93.5
75.0	80.0	81.9	89.0	93.5
77.0	80.2	82.3	90.5	
79.0	80.4	82.7	91.0	

Pyrometer reading at eutectic is 93.5

Average pyrometer reading at eutectic is 93.3, or

-32.5 degrees Centigrade

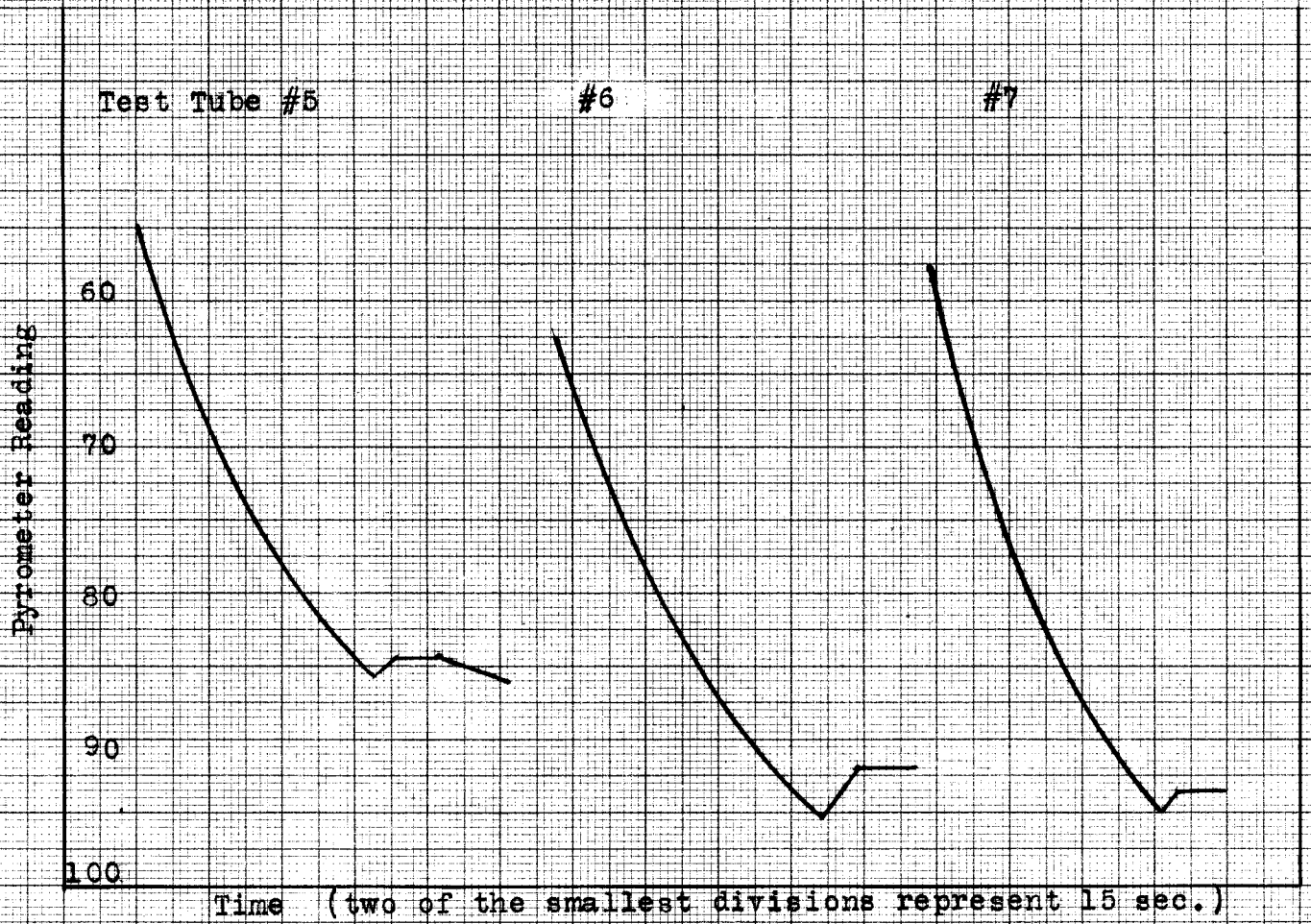
SUMMARY OF DATA ON THE ACETIC ACID-WATER SYSTEM

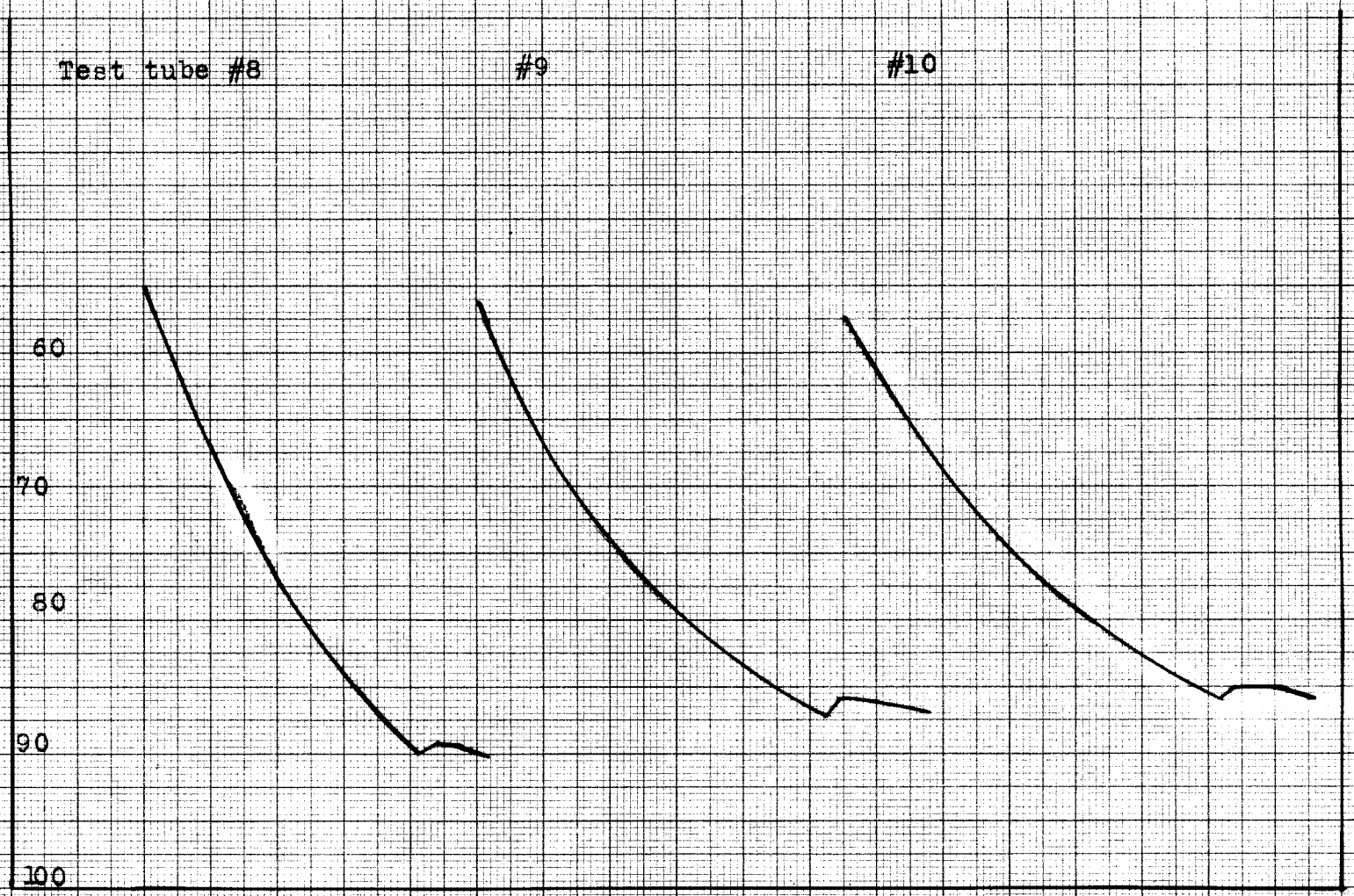
Test Tube Number	Percent Water	Pyrometer Reading	Freezing Point
1	0.00	62.2	16.5
2	8.35	70.0	5.2
3	13.42	73.6	-1.0
4	21.41	79.5	-10.0
5	29.32	84.5	-18.0
6	34.54	92.1	-29.8
7	39.56	93.5	-32.0
8	41.32	93.7	-32.5
9	48.04	91.2	-28.5
10	53.51	90.0	-26.5
11	61.89	86.6	-21.4
12	68.48	83.7	-17.0
13	74.68	82.3	-14.5
14	80.31	81.3	-13.0
15	86.81	80.0	-11.0
16	90.20	79.5	-10.0
17	92.74	78.0	-8.0
18	100.00	72.5	0.0
Eutectic Mixture	40.5	93.3	-32.5

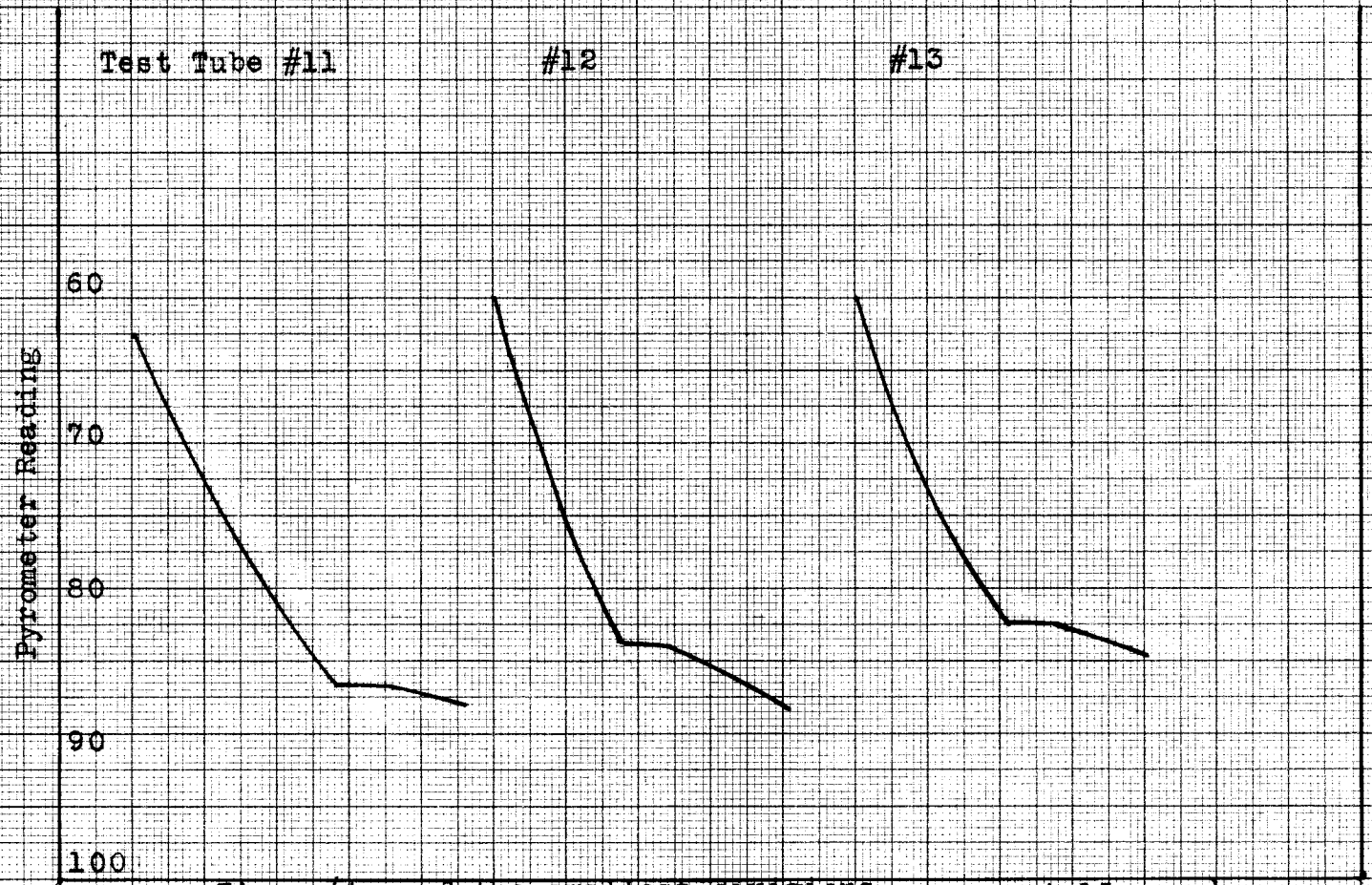
PYROMETER CALIBRATION

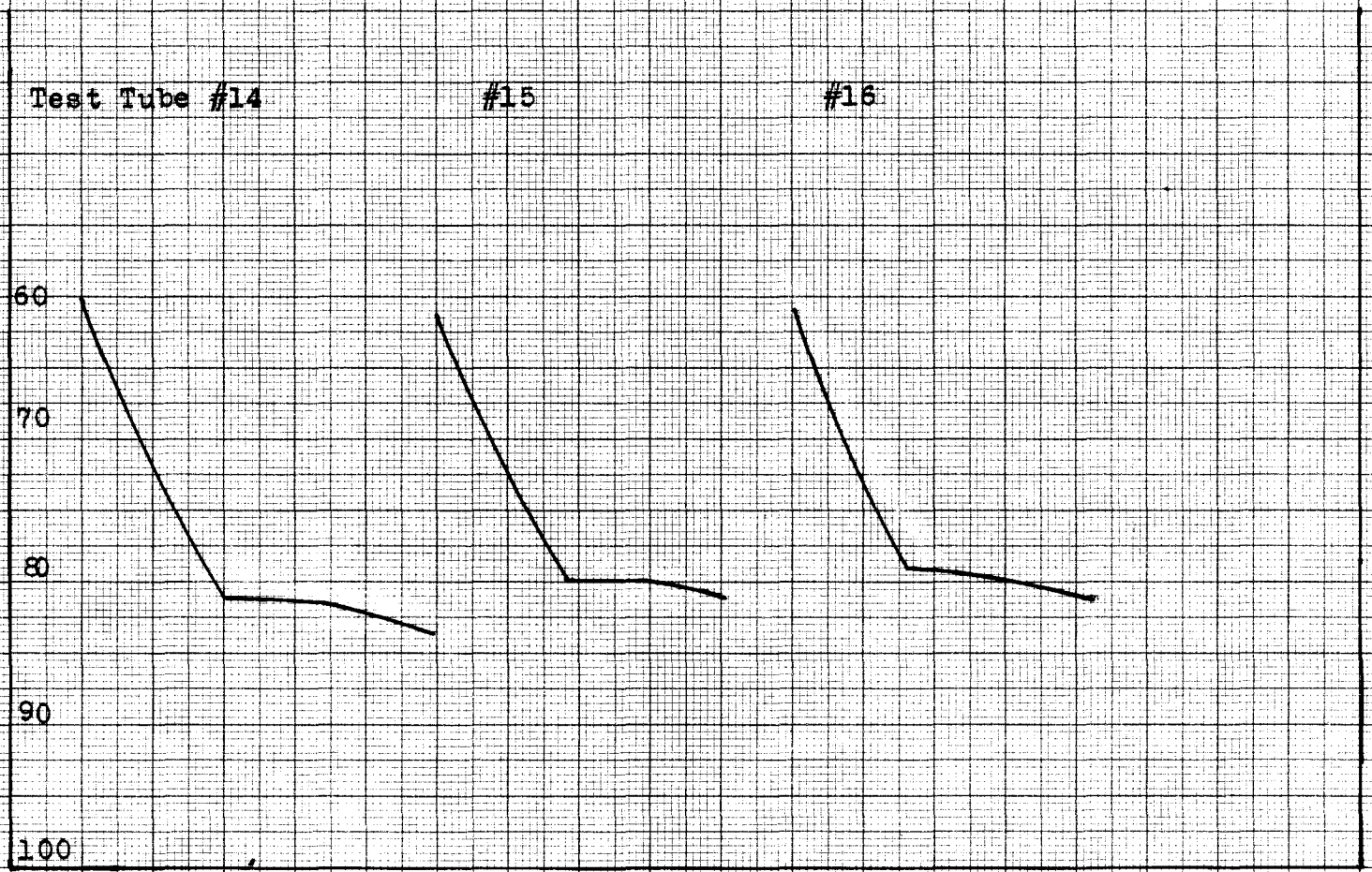
ACETIC ACID- WATER

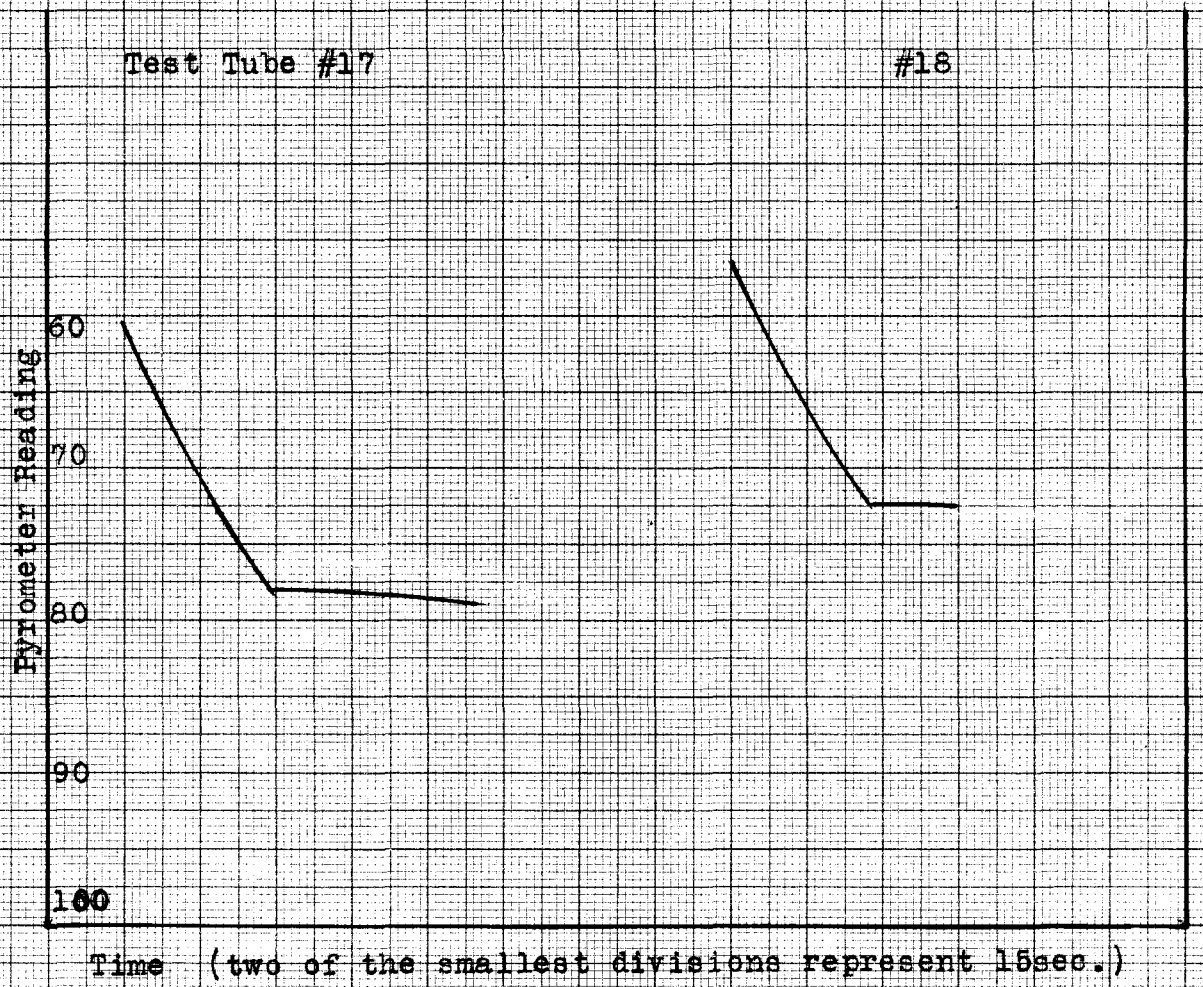
COOLING CURVES FOR THE ACETIC ACID- WATER SYSTEM


Test Tube #5
#6
#7
Pyrometer Reading
60
70
80
90
100
Time (two of the smallest divisions represent 15 sec.)

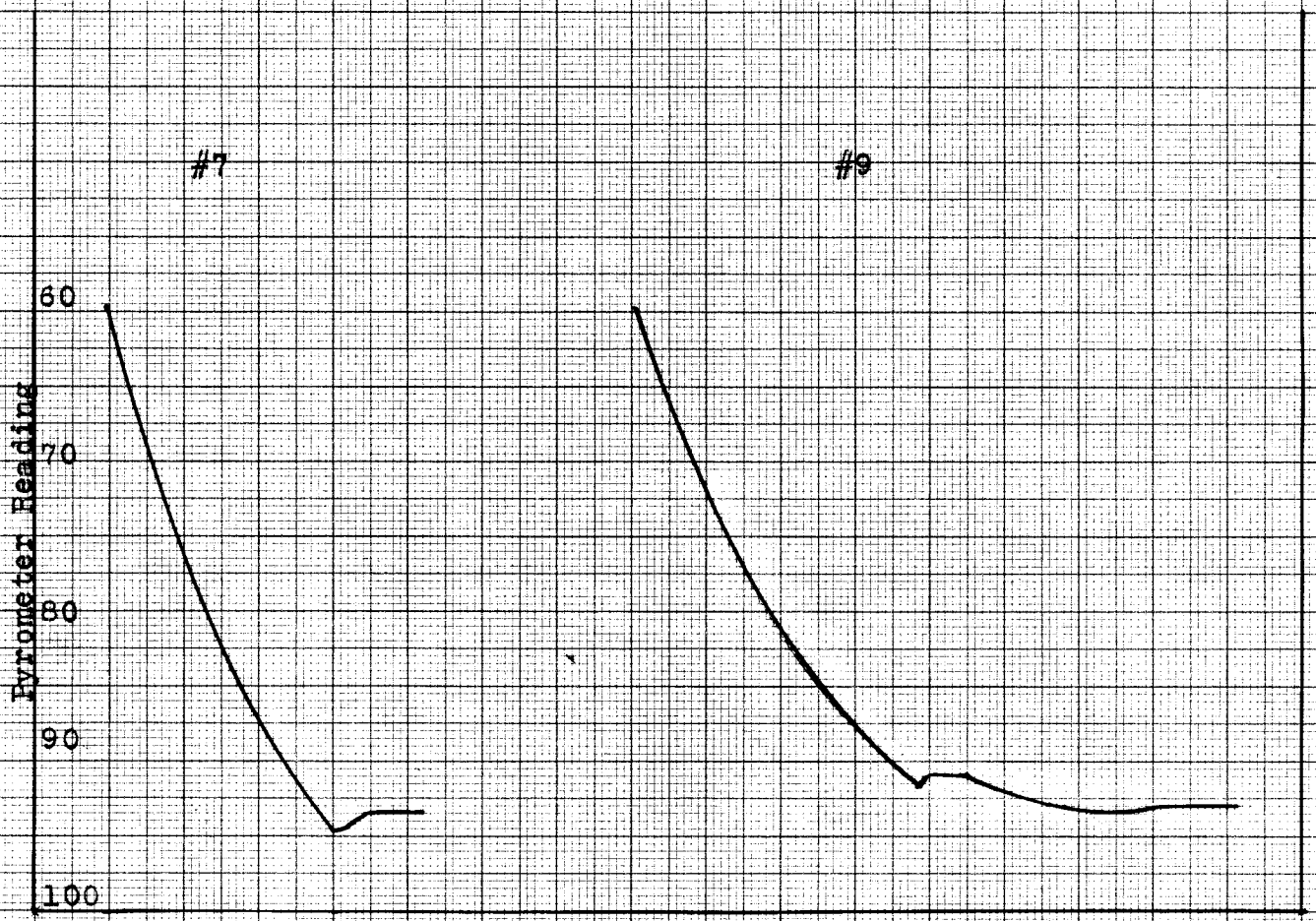

Test tube #8
#9
#10
60
70
80
90
100
Pyrometer Reading
Time (two of the smallest divisions represent 15 sec.)


Test Tube #11
#12
#13
60
70
80
90
100
Pyrometer Reading
Time (two of the smallest divisions represent 15 sec.)

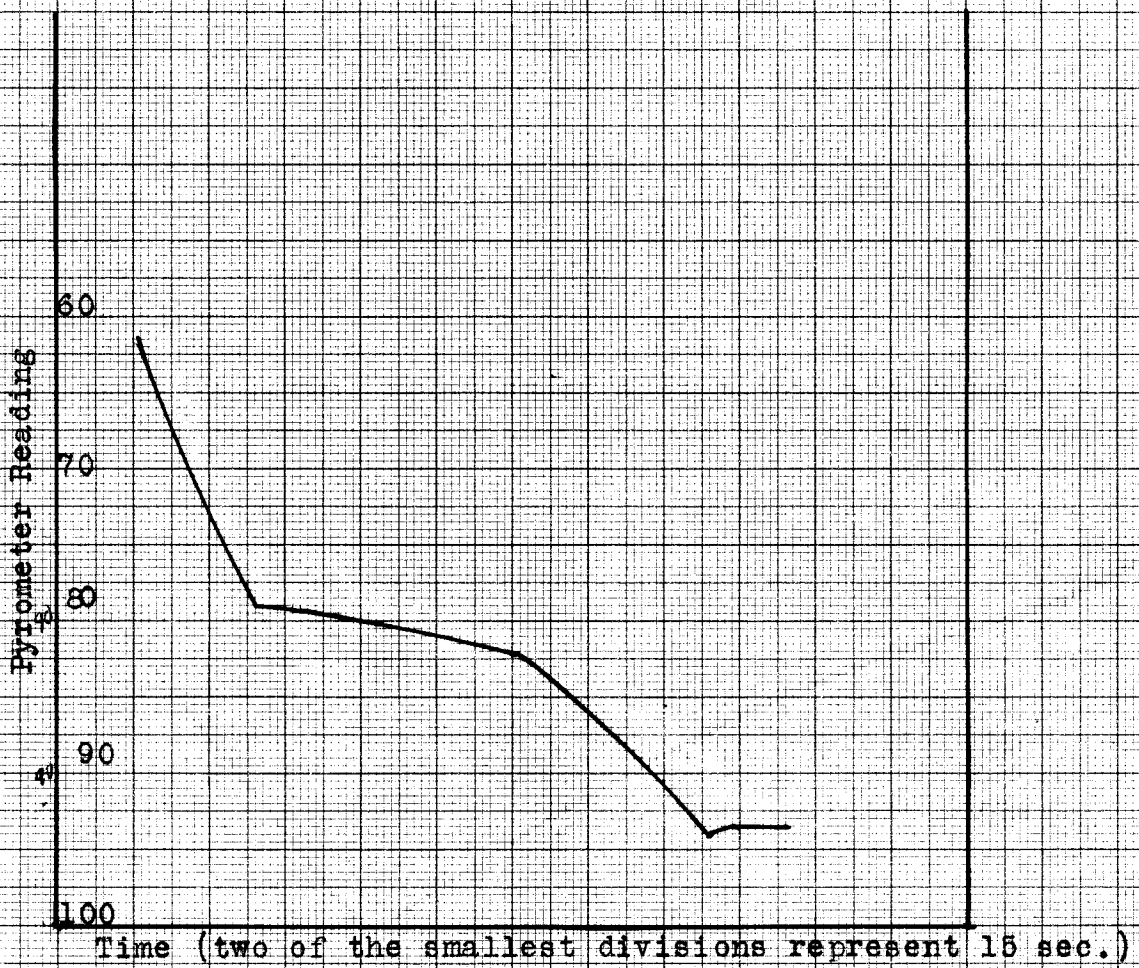

Test Tube #14
#15
#16
60
70
80
90
100
Time (two of the smallest divisions represent 15 sec.)

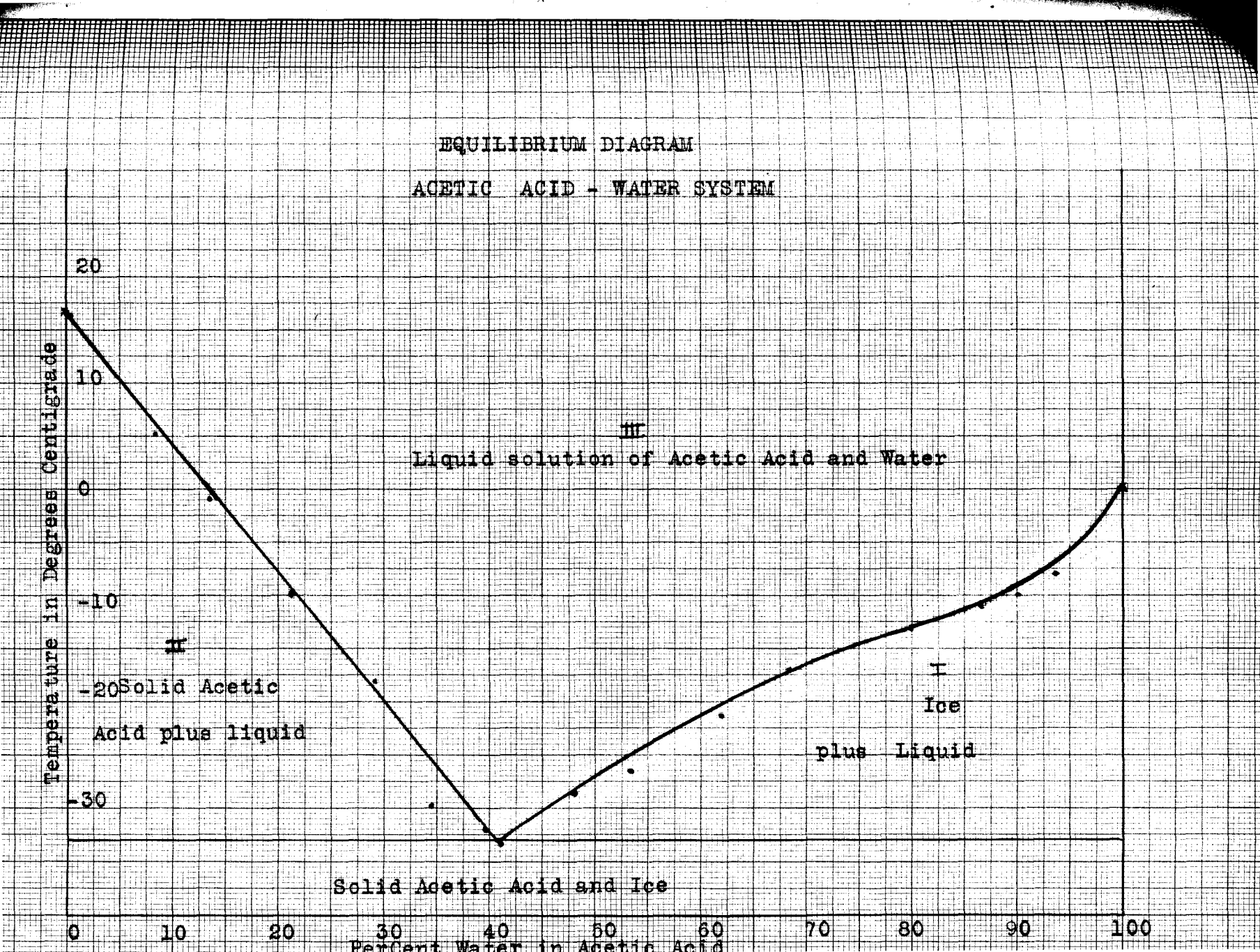

Test Tube #17
#18
Pyrometer Reading
60
70
80
90
100
Time (two of the smallest divisions represent 15sec.)

Coding Curve #7 and #9 brought down to Eutectic



Cooling curve #16 brought down to Eutectic




EQUILIBRIUM DIAGRAM
ACETIC ACID - WATER SYSTEM
Temperature in Degrees Centigrade
20
10
0
-10
-20
-30
III
Liquid solution of Acetic Acid and Water
II
Solid Acetic
Acid plus liquid
I
Ice
plus Liquid
Solid Acetic Acid and Ice
0
10
20
30
40
50
60
70
80
90
100
Per Cent Water in Acetic Acid

THE GLYCOLIC ACID-WATER SYSTEM

PERCENTAGE COMPOSITION OF THE GLYCOLIC ACID-WATER SAMPLES

Test Tube Number	Weight of Glycolic Acid in grams	Weight of Water in grams	% of Water
1	0.0000		100.0
2	0.5753	14.9352	96.27
3	0.9599	14.9357	93.96
4	1.5402	14.9540	90.66
5	1.7675	14.8083	89.33
6	2.6144	14.8281	85.01
7	4.0110	14.8128	78.69
8	4.7186	14.8394	75.87
9	6.0758	14.8704	70.99
10	6.5465	14.8789	69.44
11	9.5957	14.8643	60.77
12	11.9922	14.9646	55.51
13	11.3565	14.9427	54.51
14	5.9298	5.8653	49.72
15	19.5841	14.9217	43.24

CALIBRATION OF THE PYROMETER FOR THE GLYCOLIC ACID-WATER SYSTEM

The indicator hand of the pyrometer was set at 0 by means of a set screw on top of the instrument when both junctions of the thermocouple were at room temperature. The hot junction was then placed in water boiling at 98.8 degrees Centigrade while the cold junction was inserted in the tube containing the sample and immersed in the freezing bath. Pure liquids with known freezing points were used to calibrate the instrument. The pyrometer readings taken at the freezing point of the liquid, and the freezing point in degrees Centigrade are listed below:

Liquid	Pyrometer Reading at Freezing Point	Freezing Point in degrees C.
Benzene	68.7	5.5
Water	70.7	0.0
Aniline	75.7	-6.2
Carbon Tetrachloride	86.0	-23.0

DATA ON COOLING CURVES FOR THE GLYCOLIC ACID WATER SYSTEM

Test Tube Number	#1	#2	#3	#4	#5
Per Cent Water	100.0	96.27	93.96	90.66	89.33
Pyrometer Readings at 15 second intervals	54.5 56.0 58.0 59.8 61.5 63.0 66.5 65.9 67.2 68.2 69.5 70.7 71.5 70.7 70.7 70.7	52.6 55.3 58.5 61.2 63.5 66.5 68.5 70.3 70.5 70.6 70.7 70.8 70.8 70.8 70.9 71.1 71.2	53.6 56.7 59.0 62.0 64.5 67.2 69.5 71.2 71.4 71.5 71.5 71.5 71.5 71.5 71.6 71.7 71.8 71.9 72.0	53.5 56.0 59.0 61.5 63.5 66.2 68.5 70.1 72.1 72.2 72.3 72.3 72.3 72.3 72.3 72.5 72.6 72.7 72.8 72.9 73.0	51.5 56.5 60.0 62.0 64.0 66.5 70.3 72.0 72.5 72.5 72.5 72.5 72.5 72.5 72.6 72.7 72.8 73.0 73.2 73.5 73.7 73.9 74.3 74.7 75.2
Pyrometer Readings at Freezing Point	70.7	70.8	71.5	72.3	72.5
Freezing Point in Degrees C.	0.0	-0.2	-0.5	-2.0	-2.5

Test Tube Number	#6	#7	#8	#9	#10
Per Cent Water	85.01	78.60	75.87	70.99	69.44
Pyrometer Readings at 15 second intervals	53.9 56.0 58.6 61.1 63.5 65.8 68.2 70.2 71.8 73.1 73.0 73.1 73.1 73.1 73.3 73.5 73.8 74.0 74.3 74.4 74.6 74.9 75.1	54.0 56.0 58.0 60.0 61.5 63.0 64.5 65.5 66.5 67.8 69.0 70.0 71.0 71.8 72.5 73.5 74.7 75.5 75.2 75.1 75.1 75.2 75.3 75.5 75.6 75.7 75.8 75.9 76.0	54.5 57.0 58.9 60.5 62.2 63.5 64.5 65.5 66.5 67.5 68.5 69.3 70.2 71.1 72.0 72.8 73.5 74.5 75.3 76.5 77.0 76.5 76.5 76.5 76.5 76.6 76.7	55.5 57.0 58.9 61.5 63.0 64.8 66.5 67.3 69.0 70.3 71.5 72.2 73.1 74.2 75.5 76.2 77.2 77.7 78.4 78.0 77.7 77.7 77.7 77.7	55.5 56.5 58.9 60.0 61.8 63.2 64.5 65.5 67.0 68.2 69.2 70.1 71.0 71.9 72.4 73.0 73.8 74.8 75.4 76.3 76.9 77.3 77.9 78.5 79.0 79.2 78.3 78.3 78.3 78.5 78.8 79.1
Pyrometer Reading at Freezing Point	73.1	75.1	76.5	77.7	78.3
Freezing Point in Degrees Cen.	-3.2	-6.2	-8.5	-10.5	-11.5

Test Tube Number	#11	#12	#13	#14	#15
Per Cent Water	60.77	55.51	54.51	49.72	43.24
Pyrometer Readings at 15 second intervals	55.1 57.0 59.5 61.8 63.0 64.6 67.5 69.3 70.7 72.3 74.0 75.7 77.0 78.3 79.5 80.4 81.5 80.5 80.5 80.5 80.8 81.2 81.5 81.8 82.0	55.5 56.9 59.0 61.0 62.7 64.5 66.0 67.5 69.0 70.5 71.5 72.3 73.1 74.3 75.7 76.5 77.4 78.2 79.5 80.0 80.9 81.5 82.1 82.7 83.2 83.7 83.0 83.0 83.0 83.2 83.5	56.3 57.5 59.5 61.5 65.7 68.5 71.3 73.3 75.7 77.5 79.4 81.0 82.5 83.5 83.7 83.9 84.3 84.7 84.9 85.0 85.0 85.0	58.5 60.5 62.8 65.0 67.5 70.0 71.9 73.5 75.7 77.3 78.8 80.2 81.5 83.0 83.5 84.9 85.1 84.8 84.7 84.5 84.5 84.5	57.1 60.0 63.0 65.7 68.5 70.7 72.5 74.7 77.0 78.6 80.5 81.0 81.0 81.3 82.3 83.7 84.5 84.5 84.5
Pyrometer Readings at Freezing Point	80.5	83.0	83.7	84.5	81.0
Freezing Point in Degrees C.	-15.0	-18.7	-20.0	-21.0	-15.7

Test Tube #11 cooled down to eutectic:

59.5	72.3	81.5	81.8	83.4
61.8	74.0	80.5	82.0	83.6
63.0	75.7	80.5	82.2	83.8
64.6	77.0	80.5	82.4	83.9
67.5	78.3	80.8	82.7	84.0
69.3	79.5	81.2	83.0	84.0
70.7	80.4	81.5	83.2	84.0

Pyrometer reading at eutectic is 84.0

Test Tube #13 cooled down to eutectic:

56.3	68.5	79.3	83.9	85.0
57.5	71.3	81.0	84.3	85.0
59.5	73.3	82.5	84.7	
61.5	75.7	83.5	84.9	
65.7	77.5	83.7	85.0	

Pyrometer reading at eutectic is 85.0

Test Tube #15 cooled down to eutectic:

57.1	70.7	78.6	81.3	84.5
60.0	72.5	80.7	82.3	84.5
63.0	74.7	81.0	83.7	84.5
65.7	77.0	81.0	84.5	

Pyrometer reading at eutectic is 84.5

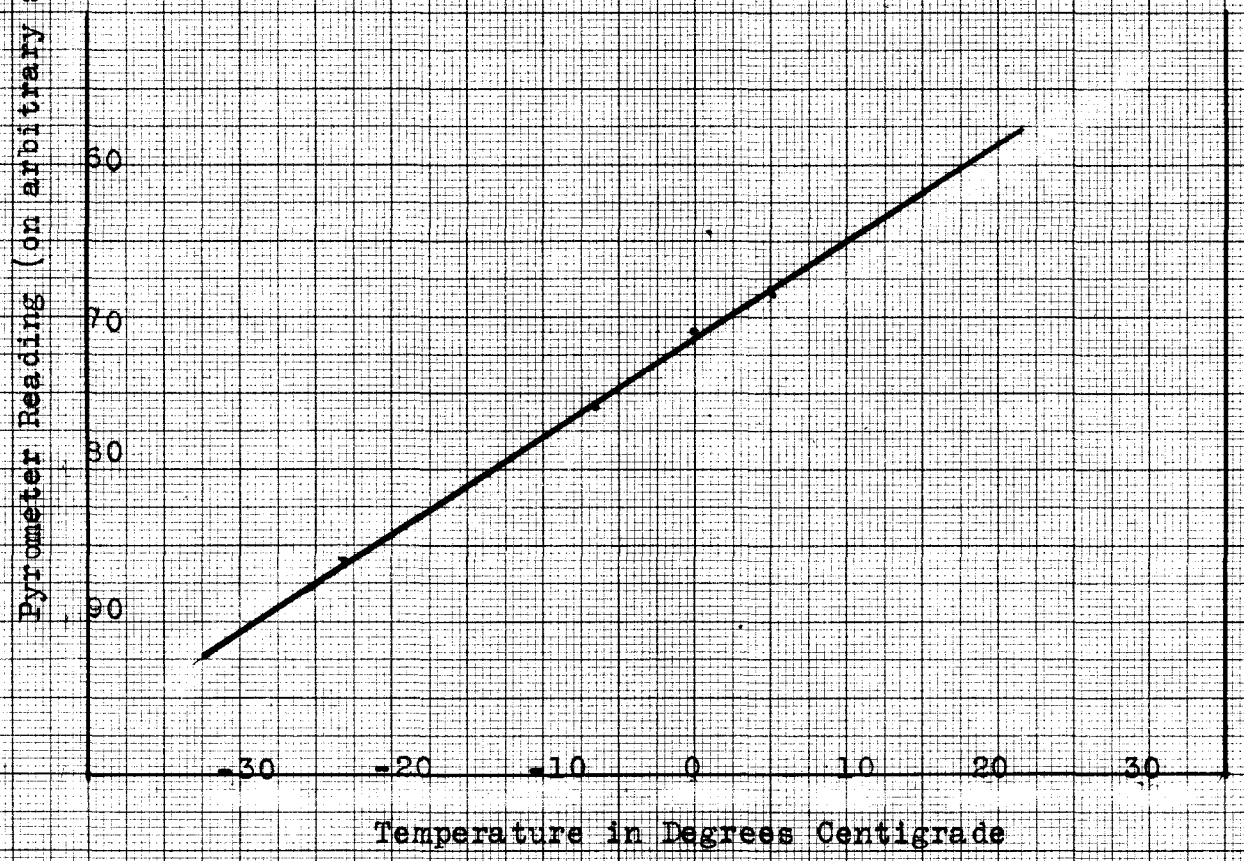
Average pyrometer reading at eutectic is 84.5, or -21.3 degrees C.

SUMMARY OF DATA ON THE GLYCOLIC ACID-WATER SYSTEM

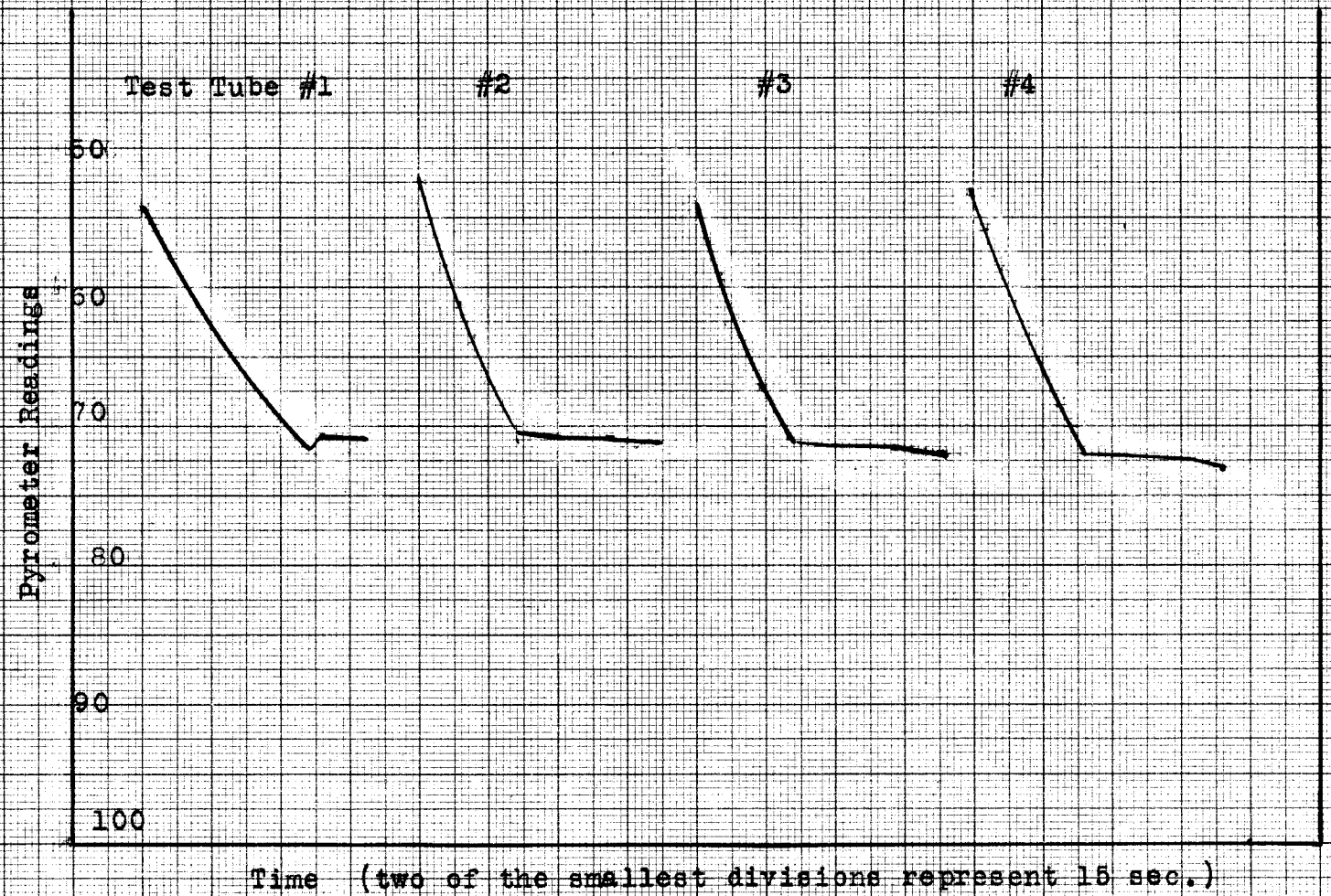
Test Tube Number	Percent Water	Pyrometer Reading	Freezing Point
1	100.00	70.7	0.0
2	96.27	70.8	-0.2
3	93.96	71.5	-0.5
4	90.66	72.3	-2.0
5	89.33	72.5	-2.5
6	85.01	73.1	-3.2
7	78.6	75.1	-6.2
8	75.87	76.5	-8.5
9	70.99	77.7	-10.5
10	69.44	78.3	-11.5
11	60.77	80.5	-15.0
12	55.51	83.0	-18.7
13	54.51	83.7	-20.0
14	49.72	84.5	-21.0
15	43.24	81.0	-15.7
Eutectic Mixture	51.00	84.5	-21.3

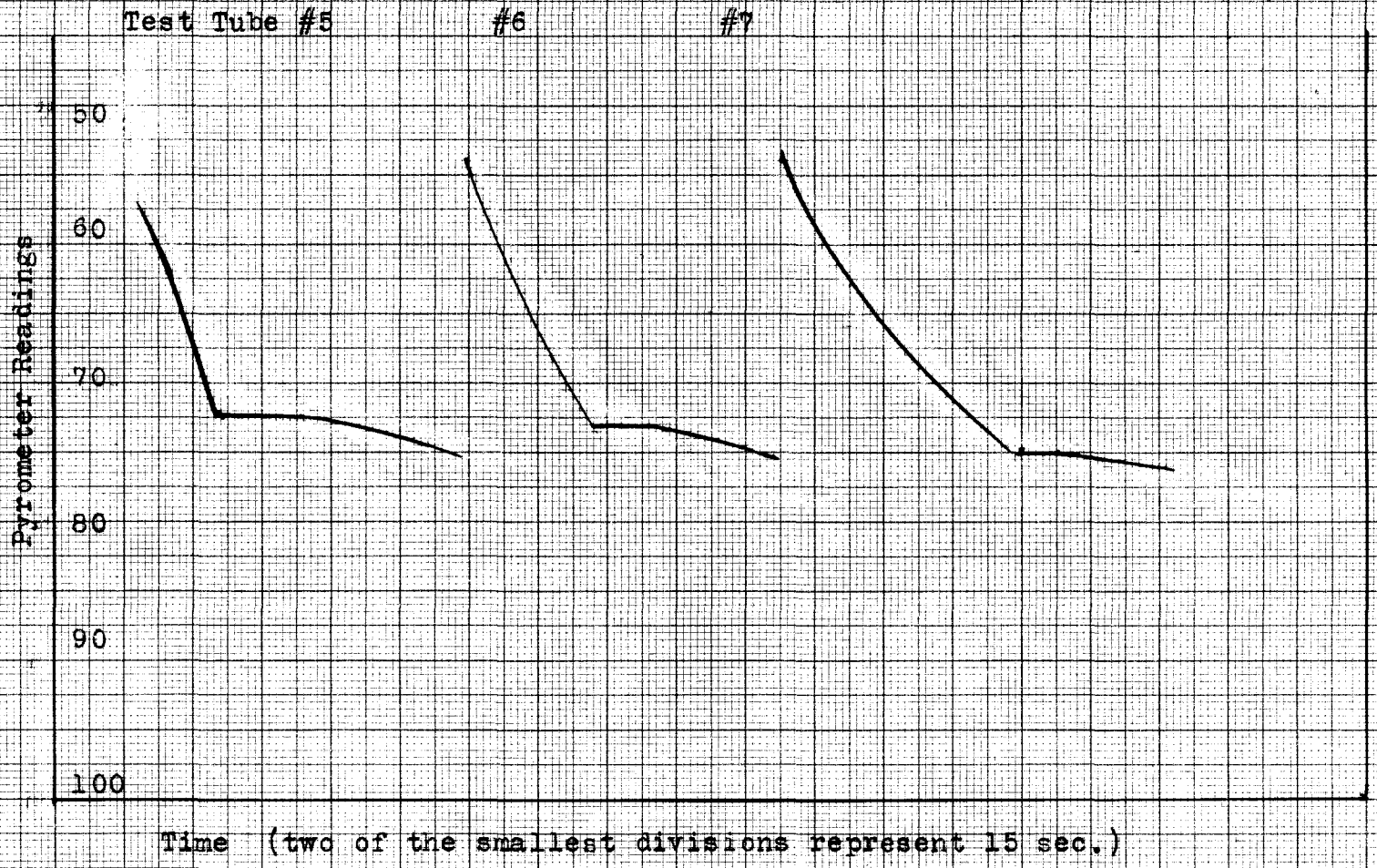
PYROMETER CALIBRATION

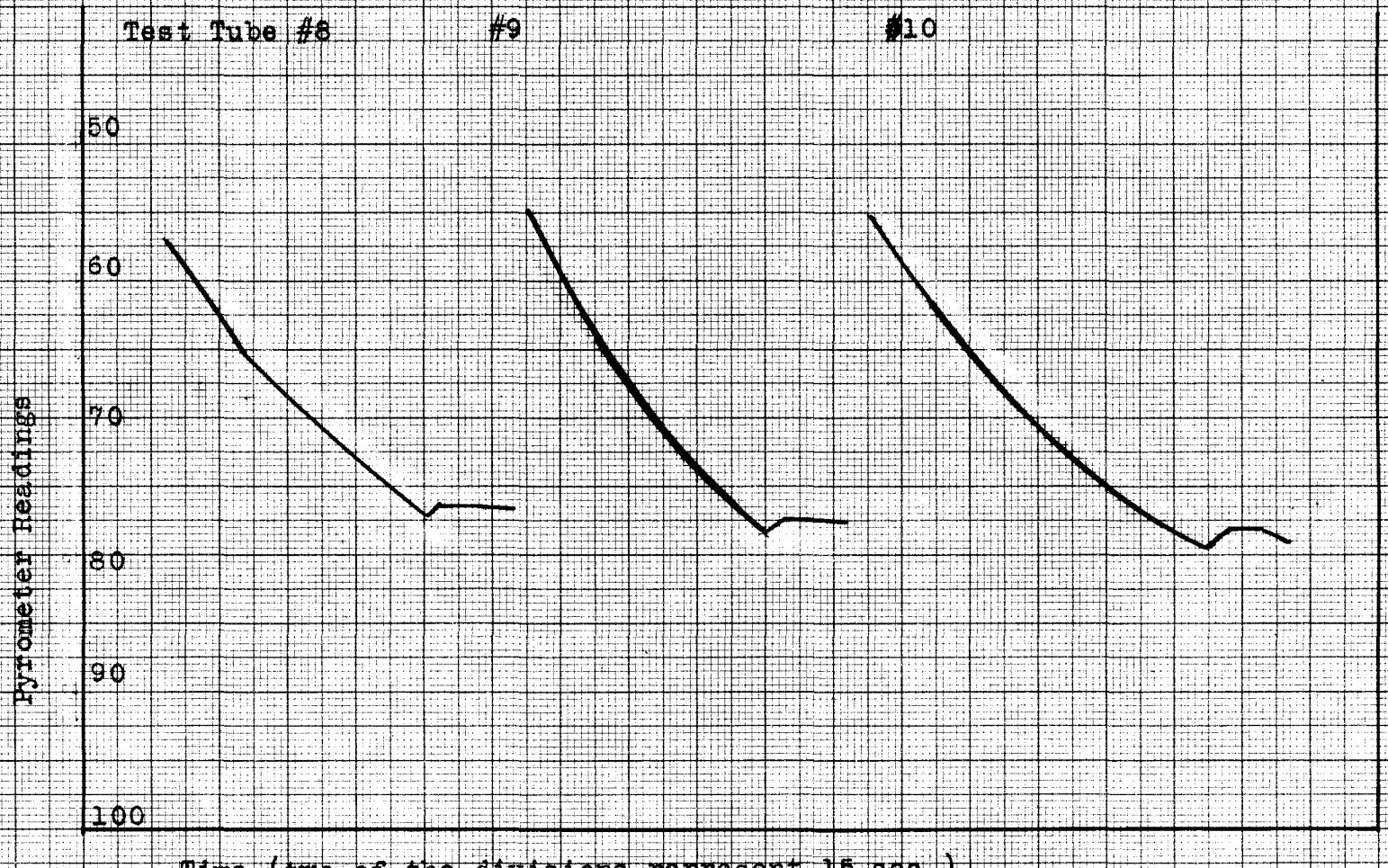
GLYCOLIC ACID - WATER

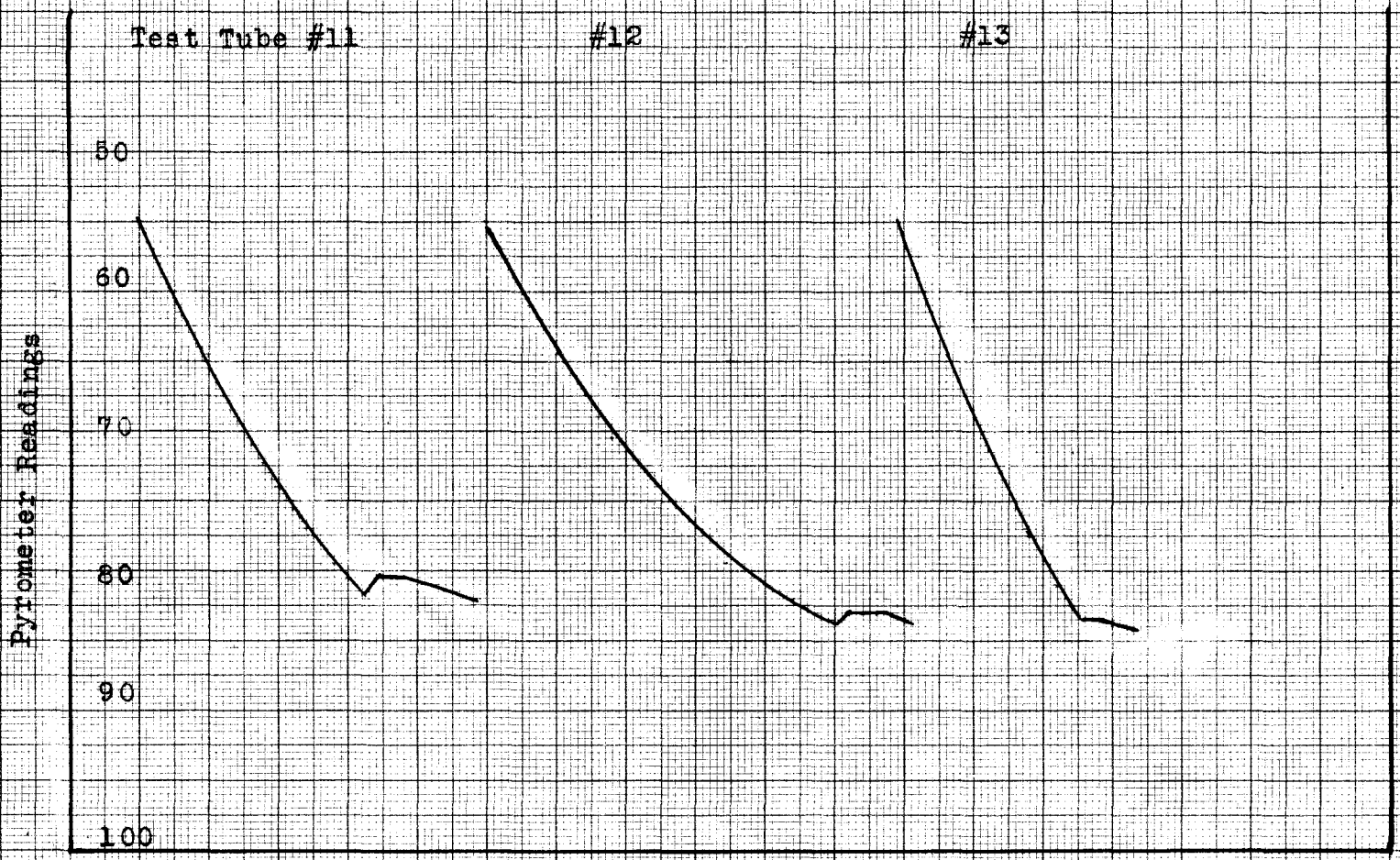


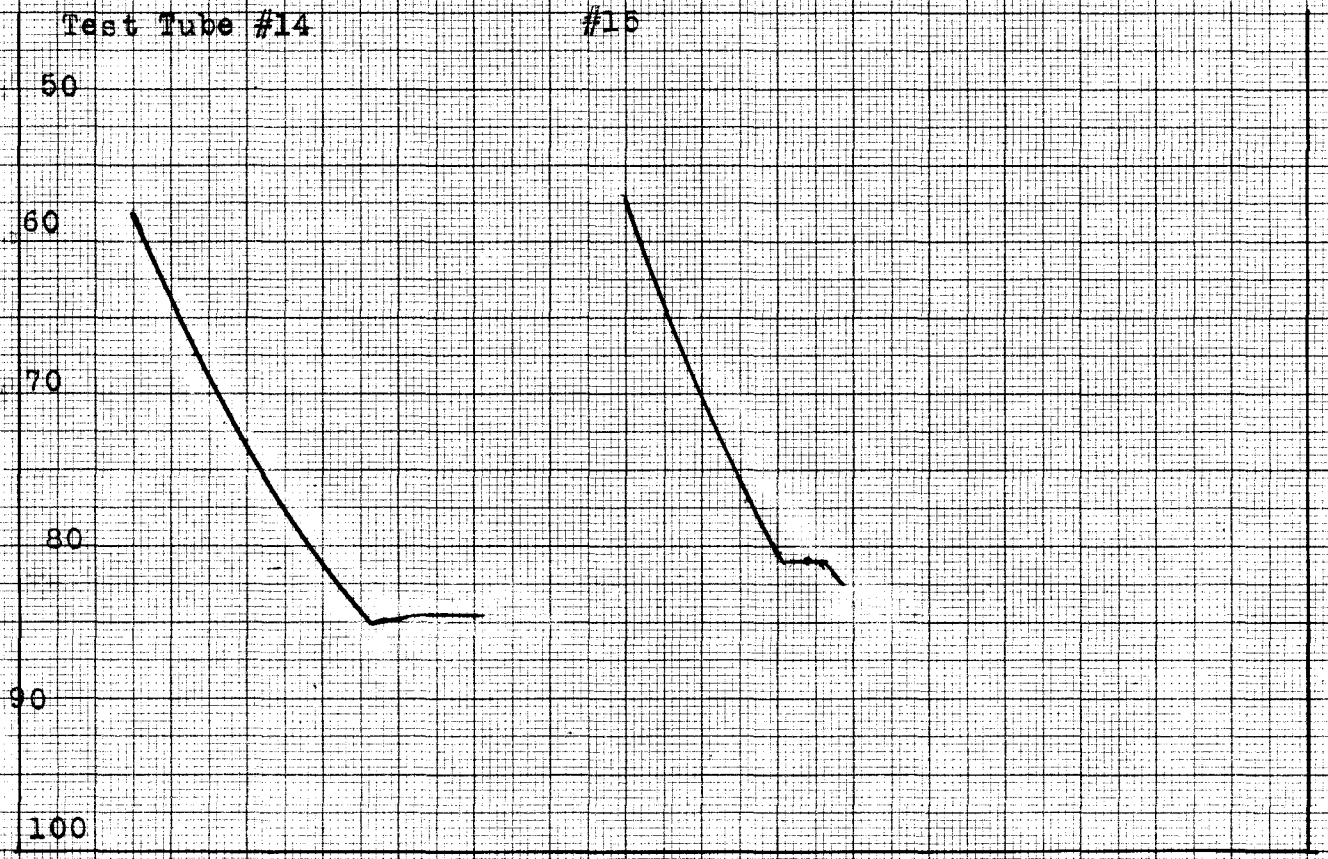
COOLING CURVES FOR THE GLYCOLIC ACID - WATER SYSTEM




Test Tube #5
#6
#7
50
60
70
80
90
100
Pyrometer Readings
Time (two of the smallest divisions represent 15 sec.)

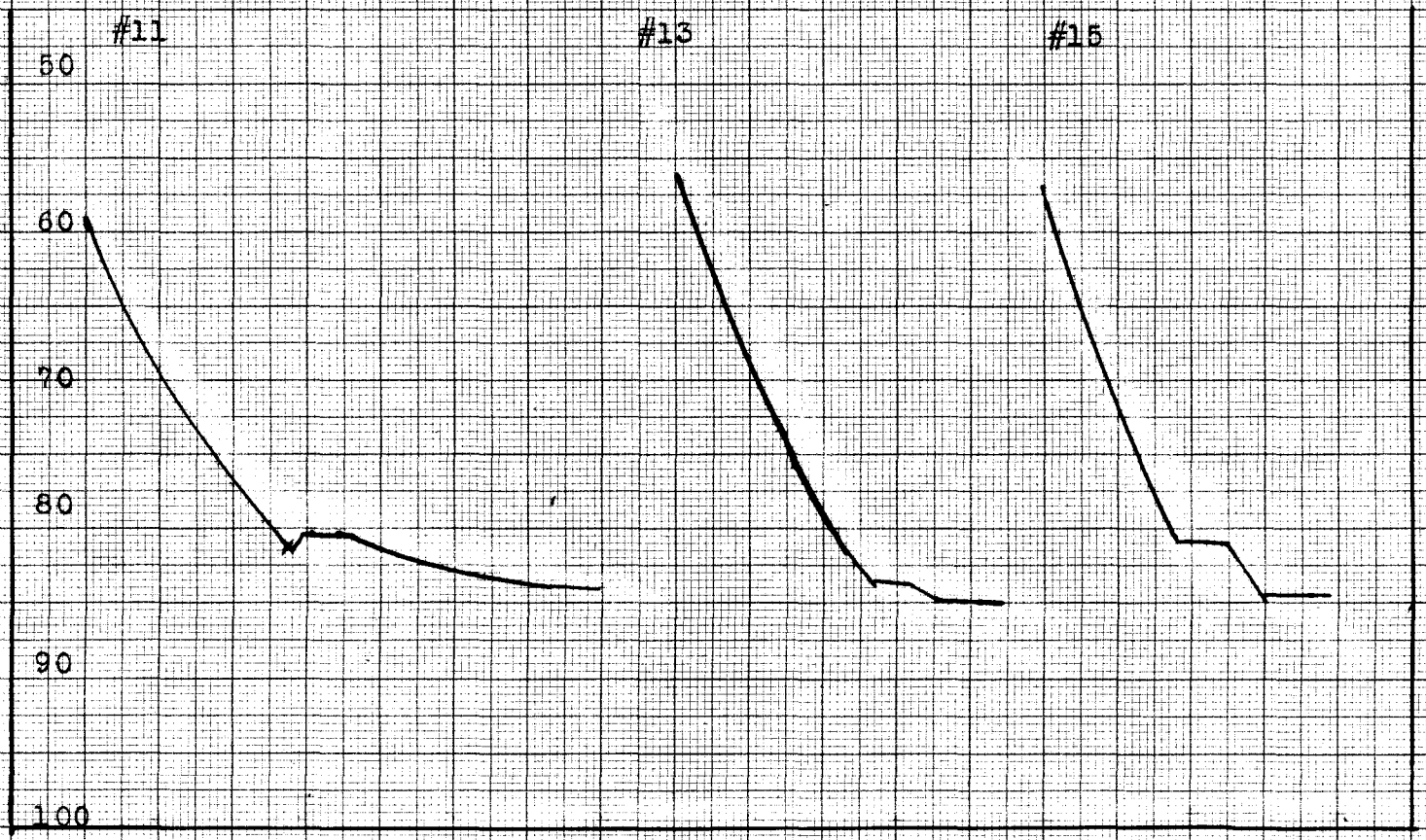

Test Tube #8
#9
#10
50
60
70
80
90
100
Pyrometer Readings
Time (two of the divisions represent 15 sec.)

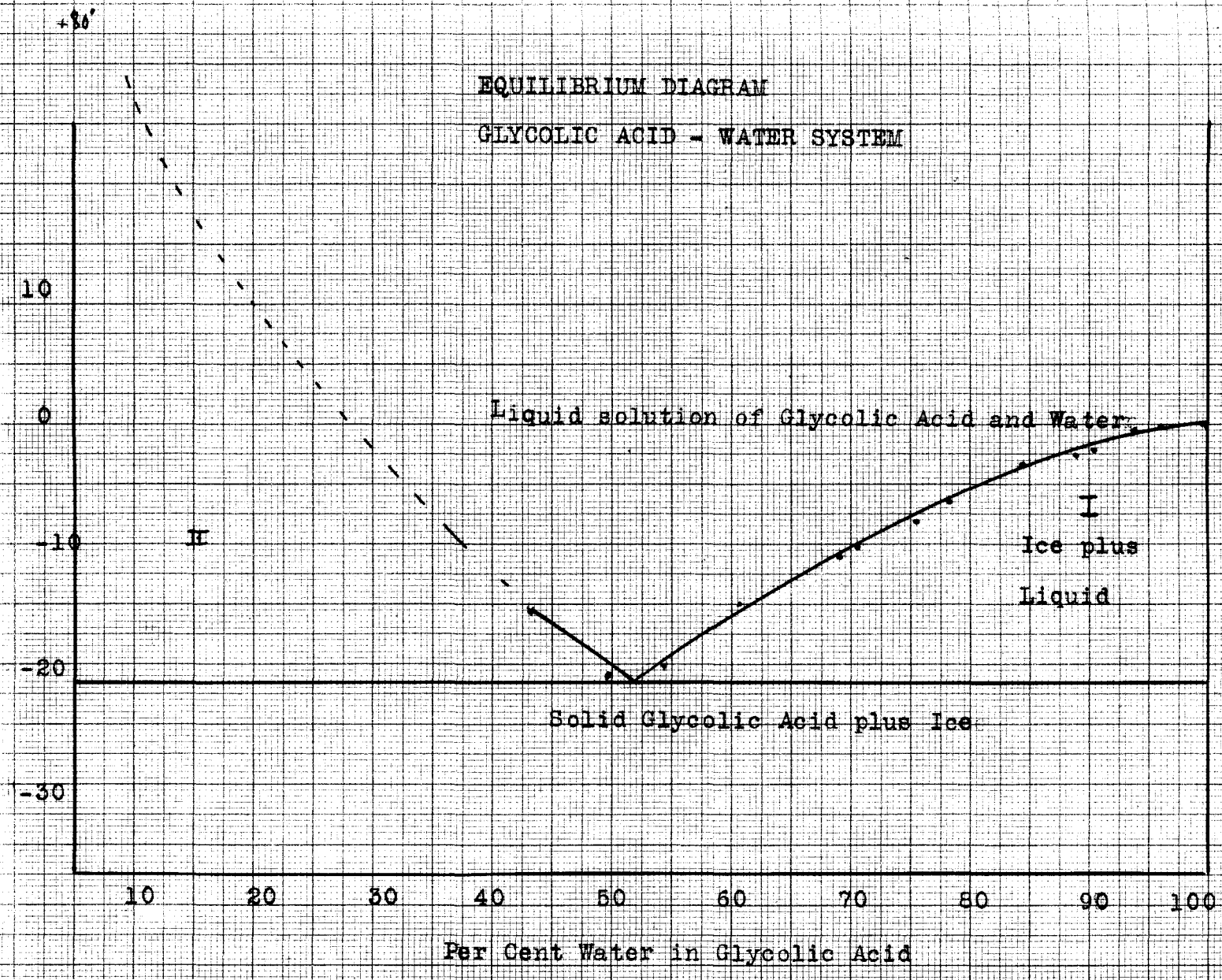

Test Tube #11
#12
#13
50
60
70
80
90
100
Pyrometer Readings
Time (two of the smallest divisions represent 15 sec.)



Time (two of the smallest divisions represent 15 sec.)

Cooling Curves #11 , #13, #15 brought down to Eutectic




+10°
EQUILIBRIUM DIAGRAM
GLYCOLIC ACID - WATER SYSTEM
10
0
-10
-20
-30
Liquid solution of Glycolic Acid and Water
Ice plus
Liquid
Solid Glycolic Acid plus Ice
10
20
30
40
50
60
70
80
90
100
Per Cent Water in Glycolic Acid

DISCUSSION

OF

BOTH SYSTEMS

DISCUSSION OF DATA

In the equilibrium diagram of the Acetic Acid-Water system, Section I represents the region in which there is present a solution of Acetic Acid-Water and some ice. In Section II we again find the solution of acid and water with solid Acetic Acid present. Section III represents the region for the existence of homogeneous solutions of Acetic Acid-Water. The horizontal line is the temperature below which all concentrations were frozen solid. The point at which the curve breaks is the lowest freezing point, or eutectic temperature of the system. The composition of the eutectic mixture having a melting point of -32.5 degrees C. is approximately 41% water.

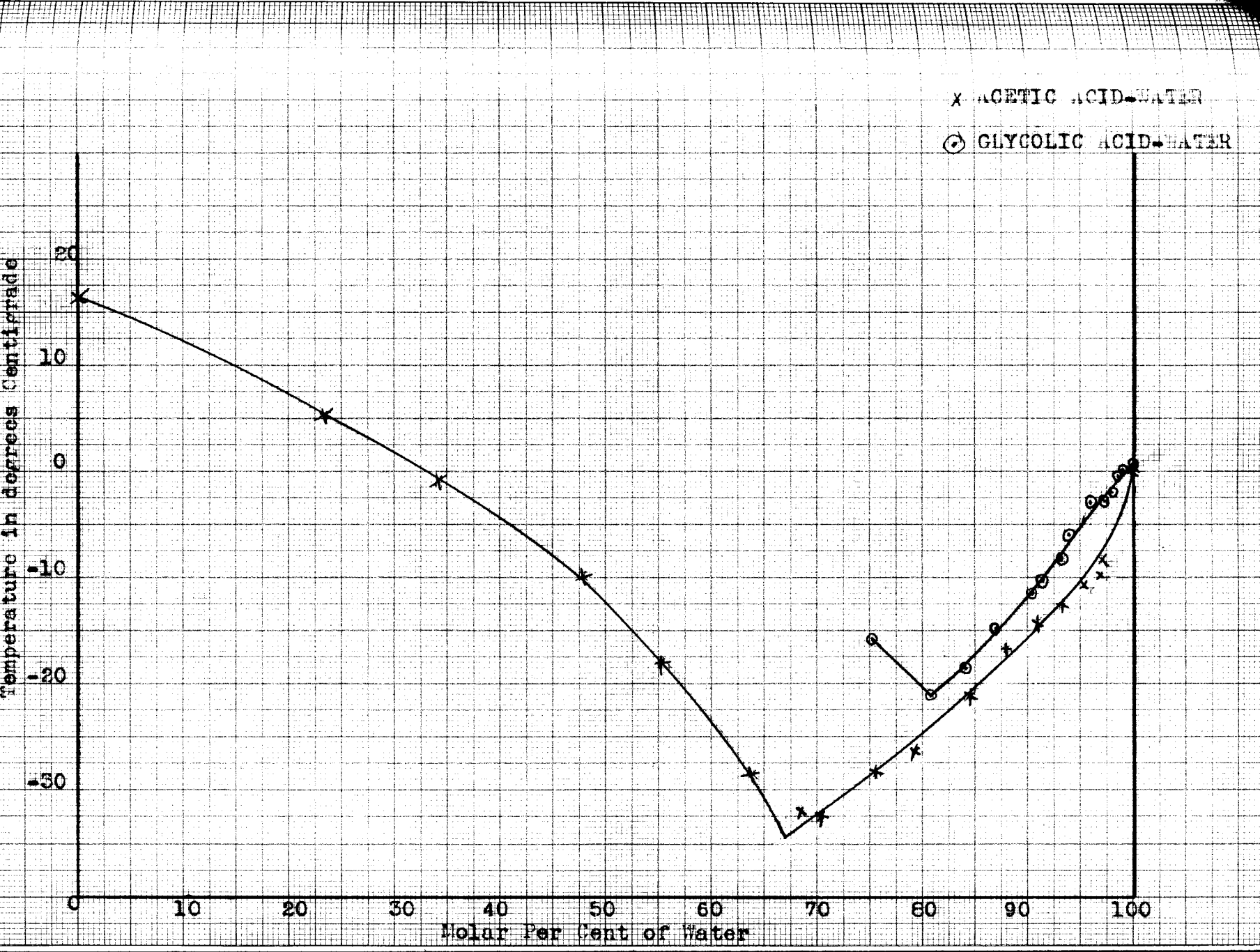
The diagram for the Glycolic Acid-Water systemis incomplete. Glycolic Acid is a white crystalline solid, melting at 79.0 degrees C. and very soluble in water. The samples were made in known varying amounts until the saturation point was nearly reached. However, a eutectic mixture was obtained when the composition equaled about 52% water. Section I of the diagram represents the region in which there is a solution of acid and water together with ice. Section II is the region in which solid Acetic Acid exists with an acid-water solution.

It was hoped, as a result of these investigations with

organic acids and water, to throw some light on the addition of water to the carbonyl bond. From the Acetic Acid-Water diagram we notice only one simple eutectic, denoting no compound formation, or in other words, no addition. From the fact that the freezing point is dependent on the relative number of moles of solute to solvent, and from the fact that the slope of the 85-100% cooling curve changes rather abruptly, it might be concluded that there is some change in the degree of complexity of either the solvent or solute molecules in solution.

As is stated above, the Glycolic Acid-Water diagram is incomplete, but it has formed only one eutectic in the portion of the diagram that has been investigated. Some means will be devised to carry this work to completion, before there can be any definite conclusion made, but as yet there is no indication of compound formation.


EQUILIBRIUM DIAGRAMS
✗ ACETIC ACID - WATER
⊙ GLYCOLIC ACID - WATER
Temperature in degrees Centigrade
20
10
0
-10
-20
-30
0
10
20
30
40
50
60
70
80
90
100
Per cent Water


X ACETIC ACID-WATER
GLYCOLIC ACID-WATER
Temperature in degrees Centigrade
20
10
0
-10
-20
-30
0
10
20
30
40
50
60
70
80
90
100
Molar Per Cent of Water

CONCLUSIONS

As there has been no evidence for compound formation in these investigations, we conclude that there is no addition to the double bond for these systems.

PRACTICAL SUGGESTIONS

1. The freezing bath should be at least 20 degrees lower than the expected freezing point. When an an ice-salt mixture was used in the earlier determinations, it was found that no definite freezing point could be obtained.

2. Calibration of the pyrometer should be checked periodically to insure against a possible source of error. The position of the adjustment screw is easily changed. Excessive tapping or unnecessary jarring should be avoided.

RECOMMENDATIONS FOR FURTHER WORK

1. Further Acetic Acid-Water samples might be investigated with a trace of a hydration catalyst to see whether this might bring about compound formation.
2. Some means of completing the cooling curve of Glycolic Acid-Water should be devised.

The thesis, "An Experimental Study of the Equilibrium Diagrams of Two Binary Systems: Acetic Acid-Water and Glycolic Acid-Water", written by Lucille Mary Trudeau, has been accepted by the Graduate School with reference to form, and by the readers whose names appear below, with reference to content. It is, therefore, accepted in partial fulfillment of the requirements for the degree of Master of Science.

Dr. Parent	May 17, 1940
Dr. Schmeing	June 4, 1940